IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of
Inventor(s): HARATA et al.

Appln. No. 10/617,700 Group Art:

Filed: July 14, 2003 Examiner:

Title: FLUID INJECTION NOZZLE

VERIFIED TRANSLATION OF PRIORITY DOCUMENT

The undersigned, of the below address, hereby certifies that he/she well knows both the English and Japanese languages, and that the attached is an accurate translation into the English language of the Certified Copy, filed for this application under 35 U.S.C. Section 119 and/or 365, of:

Application No.	Country	Date Filed
11-224141	Japan	August 6, 1999

Signed this 18th day of November, 2004.

Signature: R. Tanaka

Name: Ryoko Tanaka

Address: Toranomon Akiyama bldg.,22-13, Toranomon 1-chome, Minato-ku, Tokyo, JAPAN

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Date of Application: August 6, 1999

Application Number: Japanese Patent Application No. 11-224141

Applicant(s): DENSO CORPORATION

June 23, 2000

Commissioner,
Japan Patent Office Takahiko KONDO

Certificate Issuance No. 2000-3047847

[Name of Document]	Patent Application
[Reference Number]	ND990504
[Filing Date]	August 6, 1999
[Address]	Commissioner of Patent Office
[International Patent Classification]	F02M 69/04
[Title of the invention]	Fluid Injection Nozzle
[Number of Claims]	11

[Inventor]
    [Address]   c/o DENSO CORPORATION
                 1-1 Showa-cho, Kariya-city, Aichi-pref.
    [Name]   Akinori HARATA
[Inventor]
    [Address]   c/o DENSO CORPORATION
                 1-1 Showa-cho, Kariya-city, Aichi-pref.
    [Name]   Yukio SAWADA
[Applicant]
    [Identification Number]   000004260
    [Name]   DENSO CORPORATION
[Agent]
    [Identification Number]   100093779
    [Patent Attorney]
    [Name]   Masaki HATTORI
[Indication of Fees]
    [Prepayment Book Number]   007744
    [Amount of Payment]   21,000yen
[List of Submitted Articles]
    [Name of Articles]   Specification   1
    [Name of Articles]   Drawings   1
    [Name of Articles]   Abstract   1
    [General Power of Attorney Number]   9004765
[Request of Proof]   Needed

[Type of Document] Specification

[Title of the Invention] Fluid Injection Nozzle

[Claims]

[Claim 1] A fluid injection nozzle comprising:

a valve body having an inner peripheral surface which forms a fluid passage and which shrinks in diameter toward a fluid downstream side, and having a valve seat on the inner peripheral surface;

an injection orifice plate disposed on the fluid passage downstream side of the valve seat, having plural injection orifices to inject fluid which flows out of the fluid passage; and

a valve member, seated on the valve seat, thereby to close the fluid passage, and away from the valve seat, thereby to open the fluid passage,

characterized in that a fluid chamber, formed in approximately parallel to the injection orifice place immediately above a fluid upstream side of the plural injection orifices, communicates with the fluid passage and the plural injection orifices, and has a diameter larger than a fluid downstream side opening formed with the inner peripheral surface, and assuming that the injection orifice has a diameter d, the fluid chamber is wider than the diameter d on an outer peripheral

side of an area including the plural injection orifices.

[Claim 2] The fluid injection nozzle according to claim 1, characterized in that the fluid chamber is formed with a concave portion of a fluid injection side end portion of the valve body, and a bottom surface of the concave portion covers the orifices.

[Claim 3] The fluid injection nozzle according to claim 1, characterized in that the fluid chamber is formed with a concave portion on an anti-fluid injection side of the injection orifice plate, and a plate member held between a fluid injection side end surface of the valve body or the fluid injection side end surface and the injection orifice plate, covers the injection orifices.

[Claim 4] The fluid injection nozzle according to claim 1, 2 or 3, characterized in that the injection orifice is inclined at a predetermined angle in a direction away from a nozzle central axis toward a fluid injection direction.

[Claim 5] The fluid injection nozzle according to claim 4, characterized in that the predetermined angle is 2 to 40°.

[Claim 6] A fluid injection nozzle comprising:

a valve body having an inner peripheral surface

which forms a fluid passage and which shrinks in diameter toward a fluid downstream side, and having a valve seat on the inner peripheral surface;

an injection orifice plate disposed on the fluid passage downstream side of the valve seat, having plural injection orifices formed with approximately the same diameter in a direction away from a central axis toward a fluid injection direction, to inject fluid which flows out of the fluid passage; and

a valve member, seated on the valve seat, thereby to close the fluid passage, and away from the valve seat, thereby to open the fluid passage,

characterized in that a fluid chamber, communicating with the fluid passage and the plural injection orifices, having a diameter larger than a fluid downstream side opening formed with the inner peripheral surface, is formed between the valve body and the injection orifice plate at the fluid downstream side on the inner peripheral surface,

and the injection orifice has an inner injection orifice having a fluid inlet on the inner peripheral side of a virtual envelope line where a virtual surface extended from the inner peripheral surface to the fluid downstream side intersects the injection orifice plate,

and an outer injection orifice having a fluid inlet on the outer peripheral side of the virtual envelope line.

[Claim 7] The fluid injection nozzle according to claim 6, characterized in that the fluid chamber is flat along the injection orifice plate.

[Claim 8] The fluid injection nozzle according to claim 6 or 7, characterized in that assuming that the distance between the inner injection orifice and the outer injection orifice is L_1 and the distance between the inner injection orifices is L_2, $L_1 < L_2$ holds.

[Claim 9] The fluid injection nozzle according to claim 6, 7 or 8, characterized in that assuming that the distance between the inner injection orifice and the outer injection orifice is L_1 and the distance between the outer injection orifices is L_3, $L_1 < L_3$ holds.

[Claim 10] The fluid injection nozzle according to any one of claims 1 to 9, characterized in that the valve member has a projection member projecting toward the injection orifice plate in the fluid injection side end portion.

[Claim 11] The fluid injection nozzle according to any one of claim 1 to 10, characterized in that the

fluid injection side end surface of the valve member is a flat surface.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a fluid injection nozzle having an injection orifice plate. For example, the invention relates to a fuel injection nozzle of a fuel injection valve to inject fuel to an internal combustion engine (hereinbelow, "internal combustion engine" will be referred to as an "engine").

[0002]

[Prior Art]

Conventionally, as disclosed in DE19636396, a fuel injection valve, having a thin-plate injection orifice plate where plural injection orifices are formed on the fuel downstream side of a valve comprising of a valve member and a valve seat, to inject fuel from the respective injection orifices is known. However, in the case where the plural injection orifices are formed in the injection orifice plate, as the distance between respective injection orifices is short, liquid columns injected from the respective injection orifices collide with each other on the

downstream side of the injection orifices, thereby atomization of fuel spray may be disturbed. Note that the liquid column means liquid in column shape, injected from the injection orifice, before atomization.

[0003]

In a fuel injection valve disclosed in WO98/34026 and USP 4907748, a fuel chamber expanding outwardly in a radial direction is formed between a fuel injection side end portion of a valve body and an injection orifice plate, and injection orifices are provided in positions covered with a fuel injection side end surface of the valve body. In comparison with a case where the fuel chamber expanding outwardly in radial direction is omitted, the intervals among the respective injection orifices are wider.

[0004]

[Problems to Be Solved by the Invention]

However, in the fuel injection valve disclosed in WO98/34026 and USP 4907748, as the injection orifices in the injection orifice plate are not formed to be away from the central axis of the injection orifice plate toward a fuel injection direction, the spread of spray is narrow. Further, as the fuel chamber formed between the fuel downstream side end portion of the

valve body and the injection orifice plate is not flat, collision of inflow fuel is not sufficient at a fuel inlet of the injection orifice before the fuel flows into the injection orifice. In the case where the collision of fuel which flows into the injection orifice is insufficient, turbulence of fuel is reduced and atomization of fuel spray is insufficient.

[0005]

Further, as the distance between an outer peripheral edge of the fuel chamber and the injection orifice is short, the amount of fuel which flows into the injection orifice from the outer peripheral edge side of the fuel chamber is small. Most of the fuel flows into the injection orifice from the central portion of the fuel chamber. When the fuel flows into the injection orifice mainly from one direction, the collision of the inflow fuel is not sufficient at the fuel inlet of the injection orifice. When the collision of the fuel which flows into the injection orifice is not sufficient, the turbulence of the fuel flow into the injection orifice is reduced, and atomization of fuel spray is insufficient.

[0006]

It is known that the fuel spray can be atomized

by reducing the diameter of the injection orifice. However, to obtain a desired fuel injection amount by reducing the diameter of the injection orifice, the number of injection orifices must be increased. If the number of the injection orifices is increased, the distance between the injection orifices is shorter, and liquid columns immediately below the injection orifices may easily collide with each other. The collision between the liquid columns disturbs atomization of fuel. As disclosed in WO98/34026 and USP 4907748, in a structure where the injection orifices are provided in positions covered with the fuel injection side end surface of the valve body, the number of injection orifices which can be formed so as to avoid collision of liquid columns on the downstream side of the injection orifices is limited.

An object of the present invention is to provide a fluid injection nozzle to atomize spray.

[0007]

[Means to Solve the Problems]

In the fluid injection nozzle according to claim 1 of the present invention, as the fluid chamber is formed in approximately parallel to the injection orifice plate, the fluid which flowed in toward the

injection orifice plate flows along the injection orifice plate. Accordingly, the fluid does not directly flows into the injection orifice but collision occurs at the fluid inlet. In this arrangement, the turbulence caused in a liquid column injected from the injection orifice is increased and atomization can be promoted.

[0008]

Further, the fluid chamber has a diameter larger than the fluid downstream side opening formed with the inner peripheral surface, and assuming that the injection orifice has a diameter d, the fluid chamber is wider than the diameter d on the outer peripheral side of the area including the plural injection orifices. Accordingly, the fluid easily flows into the respective injection orifices not only from the central portion of the fluid chamber but also from the outer peripheral edge of the fluid chamber. As the fluid flows running approximately toward each other uniformly collide with each other at the fluid inlet of the injection orifice, the turbulence caused in a liquid column injected from the injection orifice is increased and atomization can be promoted.

[0009]

In the fluid injection nozzle according to claim 2 or 3 of the present invention, the fluid chamber is formed with a concave portion on the a fluid injection side of the injection orifice plate, and a plate member held between an end surface of the valve body or the end surface of the valve body and the injection orifice plate, covers the injection orifices. As the fluid flows, guided by the valve body or the plate member along the injection orifice plate, into the injection orifice, the energy of collision of the fluid at the fluid inlet of the injection orifice is increased. Accordingly, the turbulence caused in a liquid column injected from the injection orifice is increased and atomization can be promoted.

In the fluid injection nozzle according to claim 4 or 5 of the present invention, the injection orifice is inclined at a predetermined angle in the direction away from a nozzle central axis toward the fluid injection direction. In this arrangement, the spread of spray is increased.

[0010]

In the fluid injection nozzle according to claim 6 of the present invention, the fluid chamber, having a diameter larger than the fluid downstream side opening

formed with the inner peripheral surface having the valve seat, is formed between the valve body and the injection orifice plate, on the fluid downstream side of the inner peripheral surface having the valve seat. The injection orifice has an inner injection orifice having a fluid inlet on the inner peripheral side of a virtual envelope line where a virtual surface extended from the inner peripheral surface to the fluid downstream side intersects the injection orifice plate, and an outer injection orifice having a fluid inlet on the outer peripheral side of the virtual envelope line. The fluid flowing toward the injection orifice plate along the inner peripheral surface is divided into a flow toward the inner peripheral side of the virtual envelope line and a flow toward the outer peripheral side of the virtual envelope line. The fluid flow from the virtual envelope line toward the inner peripheral side is injected from the inner injection orifice, while the fluid flow from the virtual envelope line toward the outer peripheral side is injected from the outer injection orifice. Even in a case where the inner injection orifice and the outer injection orifice are inclined in approximately the same direction, the fluid is injected in directions away from each other.

Accordingly, even in a case where the diameter of the injection orifice is reduced for atomization of fluid spray, the number of injection orifices is increased so as to obtain a desired injection amount, the injection orifices are provided on the inner peripheral side and the outer peripheral side from the virtual envelope line, and the inner injection orifice and the outer injection orifice are close to each other, collision between liquid columns injected from the inner injection orifice and the outer injection orifice immediately below the injection orifices can be prevented, and the fuel spray can be atomized.

[0011]

In the fluid injection nozzle according to claim 7 of the present invention, as the fluid chamber is flat along the injection orifice plate, the fluid which flowed in toward the injection orifice plate flows along the injection orifice plate. Accordingly, the fluid does not directly flow into the injection orifice but uniform collision occurs at the fluid inlet. In this arrangement, the turbulence caused in a liquid column injected from the injection orifice is increased and atomization can be promoted.

[0012]

In the fluid injection nozzle according to claim 8 of the present invention, assuming that the distance between the inner injection orifice and the outer injection orifice is L_1 and the distance between the inner injection orifices is L_2, $L_1 < L_2$ holds. As the flows of the fluid respectively into the inner injection orifice and the outer injection orifice are in the directions away from each other, collision between the fluid flows injected from the inner injection orifice and the outer injection orifice immediately below the injection orifices can be avoided even if the distance L_1 is shortened. On the other hand, by lengthening the distance between the inner injection orifices, in which flows of the fluid from the virtual envelope line in the same direction to the inner peripheral side enter, collision between the fluid flows immediately below the inner injection orifices can be avoided.

[0013]

In the fluid injection nozzle according to claim 9 of the present invention, assuming that the distance between the inner injection orifice and the outer injection orifice is L_1 and the distance between the outer injection orifices is L_3, $L_1 < L_3$ holds. As flows

of the fluid into the inner injection orifice and the outer injection orifice are in the different directions, collision between the fluid flows injected from the inner injection orifice and the outer injection orifice immediately below the injection orifices can be avoided even if the distance L_1 is shortened. On the other hand, by lengthening the distance between the outer injection orifices, in which flows of the fluid from the virtual envelope line in the same direction to the outer peripheral side enter, collision between the fluid flows immediately below the outer injection orifices can be avoided.

[0014]

In the fluid injection nozzle according to claim 10 of the present invention, the valve member has a projection member projecting toward the injection orifice plate in the fluid injection side end portion. As the amount of fluid retained between the valve member and the injection orifice plate upon valve opening is reduced, the error of fluid injection amount due to injection of retained fluid can be reduced, thus the fluid injection amount can be controlled with high precision.

In the fluid injection nozzle according to claim

11 of the present invention, the fluid injection side end surface of the valve member is a flat surface. Accordingly, as the fluid flows along the fluid injection side end surface of the valve member, the flows of the fluid to the respective injection orifices collide with each other at the inlets of the injection orifices, and atomization of the fluid can be promoted.

[0015]

[Working Examples]

Hereinbelow, plural embodiments showing working examples of the present invention will be described with reference the drawings.

(First Working Example)

FIG. 2 shows an example where a fluid injection nozzle according to a first working example is used in a gasoline engine fuel injection valve.

A casing 11 of a fuel injection valve 1 is molded resin covering a magnetic pipe 12, a fixed iron core 30, a coil 41 wound around a spool 41, and the like. A valve body 13 is connected to the magnetic pipe 12 by laser welding or the like. A nozzle needle 20 as a valve member is reciprocatably accommodated in the magnetic pipe 12 and the valve body 13. A contact member 21 of the nozzle needle 20 can be seated on a

valve seat 14a formed on the inner peripheral surface 14 of the valve body 13. The inner peripheral surface 14 is formed in an inner peripheral wall of the valve body 13 forming a fuel passage 50 as a fluid passage, and the inner peripheral surface has a diameter shrunk toward the fuel injection side.

[0016]

As shown in FIG. 1, the injection nozzle of the fuel injection valve 1 is constructed with the valve body 13, the nozzle needle 20 and an injection orifice plate 25. A concave member 15 is formed in a fuel injection side end portion of the valve body 13. A flat disc-shaped fuel chamber 51 is formed in parallel to and along the injection orifice plate 25 between the concave member 15 and the injection orifice plate 25. The fuel chamber 51, as a liquid chamber, communicates with the fuel passage 50 on the fuel downstream side of the valve seat 14a, and the diameter of the fuel chamber 51 is larger than that of a fuel downstream side opening formed with the inner peripheral surface 14. The fuel chamber 51 is divided into an inner fuel chamber 52 and an outer fuel chamber 53 from a virtual envelope line 200, where a virtual surface extended from the inner peripheral surface 14 toward the

injection orifice plate 25 intercepts the injection orifice plate 25. In FIG. 1(B), reference numeral 201 denotes an outer peripheral edge of the fuel chamber 51.

[0017]

A fuel injection side end surface 20a of the nozzle needle 20 has a flat shape. As shown in FIG. 2, a connection member 22 provided on the opposite side to a contact member 21 of the nozzle needle 20 is connected to a movable iron core 31. The fixed iron core 30 and a nonmagnetic pipe 32, the nonmagnetic pipe 32 and the magnetic pipe 12 are respectively connected by laser welding or the like.

[0018]

As shown in FIG. 1, the injection orifice plate 25, having a thin disc shape, is provided in the fuel injection side end portion of the valve body 13. The injection orifice plate 25 is in contact with a fuel injection side end surface 13a of the valve body 13, and is laser-welded to the valve body 13. Four injection orifices 25a, 25b, 25c and 25d are formed in the injection orifice plate 25 on the same circumference. The injection orifices 25a, 25b, 25c and 25d are formed with the same diameter d_1 away from a central axis 26 of the injection orifice plate 25

toward a fuel injection direction. The fuel chamber 51 is expanded by d_2 toward the outer peripheral side of an area where the injection orifices 25a, 25b, 25c and 25d are provided. That is, the distance from the outer peripheral side positions of fuel inlets of the injection orifices 25a, 25b, 25c and 25d to the outer peripheral edge 201 of the fuel chamber 51 is d_2. $d_1 \leq d_2$ holds.

[0019]

The respective injection orifices are covered with a bottom surface 15a of the concave member 15, and are opened in the outer fuel chamber 53. The injection orifices 25a and 25b, and the injection orifices 25c and 25d are respectively formed at the same gradient angle α in the same direction to the central axis 26 of the injection orifice plate 25. $2° \leq \alpha \leq 40°$ holds. The direction in which injection is made from the injection orifices 25a and 25b and the direction in which injection is made from the injection orifices 25c and 25d are opposite by 180°. The fuel injection valve 1 performs two-directional injection.

[0020]

As shown in FIG. 2, a spring 35, biasing the nozzle needle 20 in the direction of the valve seat 14a,

is provided on the fuel injection side of an adjusting pipe 34. The biasing force of the spring 35 biasing the nozzle needle 20 can be controlled by changing an axial directional position of the adjusting pipe 34.

[0021]

The coil 41 wound around the spool 40 is positioned in the casing 11 so as to cover around the respective end portions of the fixed iron core 30 and the magnetic pipe 12 holding the nonmagnetic pipe 32 therebetween and the nonmagnetic pipe 32. The coil 41 is electrically connected with a terminal 42. A voltage applied to the terminal 42 is applied to the coil 41.

[0022]

Next, the actuation of the fuel injection valve 1 will be described.

(1) While energization to the coil 41 is off, the movable iron core 31 and the nozzle needle 20 move to the valve seat 14a side by the biasing force of the spring 35, and the contact member 21 is seated on the valve seat 14a. Accordingly, the fuel passage 50 is closed and fuel is not injected from the respective injection orifices.

[0023]

(2) When energization to the coil 41 is turned on, a magnetic attraction force to attract the movable iron core 31 to the fixed iron core 30 side is caused in the coil 41. The movable iron 31 is attracted to the fixed iron core 30 side by the magnetic attraction force, then the nozzle needle 20 is also moved to the fixed iron core 30 side, and the contact member 21 is moved away from the valve seat 14a. Then the fuel passage 50 is opened, and the fuel is injected from the respective injection orifices.

[0024]

The fuel flowing along the inner surface 14 toward the injection orifice plate 25 is divided into a flow which collides against the injection orifice plate 25 and runs toward the center in the inner fuel chamber 52 along the injection orifice plate 25 and a flow which runs along the injection orifice plate 25 toward the outside in a radial direction in the outer fuel chamber 53. A part of the fuel flow toward the outside in the radial direction in the outer fuel chamber 53 passes between the respective injection orifices and collides against an inner peripheral wall of the concave member 51 at the outer peripheral edge 201 of the fuel chamber 51. As the distance d_2 between the

outer peripheral side positions of the respective injection orifices and the outer peripheral edge 201 of the fuel chamber 51 is equal to or greater than the injection orifice diameter d_1, the flow direction of the fuel collided against the inner peripheral wall of the concave member 51 at the outer peripheral edge 201 is changed to a direction toward the center of the fuel chamber 51. This fuel flow toward the center of the fuel chamber 51 and the fuel flow toward the outside in the radial direction in the outer fuel chamber 53 uniformly collide with each other immediately above the fuel inlets of the respective injection orifices then flow into the respective injection orifices. Accordingly, turbulences are caused in liquid columns injected from the respective injection orifices, and atomization is promoted.

[0025]

As described above, the injection orifices 25a and 25b and the injection orifices 25c and 25d are respectively formed at the same gradient angle α in the same direction to the central axis 26 of the injection orifice plate 25, thereby two-directional injection is realized. As the respective injection orifices are opened in the outer fuel chamber 53 and are away from

each other, collision among liquid columns injected from the injection orifices 25a and 25b and the injection orifices 25c and 25d immediately below the respective injection orifices can be prevented. Accordingly, atomization of the inject fuel can be promoted.

[0026]

As the fuel injection side end surface 20a of the nozzle needle 20 has a flat shape, and the fuel chamber 51 has a flat shape along the injection orifice plate, the fuel flowed toward the injection orifice plate 25 flows along the injection orifice plate 25. Accordingly, the fuel does not directly flow into the injection orifices but uniform collision at the fuel inlets of the injection orifices. This causes turbulences in the liquid columns injected from the injection orifices and promotes atomization. Further, the respective injection orifices are formed so as to be away from the central axis 26 toward the fuel injection direction. Accordingly, the fuel injected from the respective injection orifices becomes spray which spreads in a wide range.

[0027]

(Second Working Example)

FIG. 3 shows the fuel injection valve according to the second working example of the present invention. The constituent elements substantially the same as those of the first working example have the same reference numerals, and the explanations thereof will be omitted.

In the second working example, a concave member is not formed in the valve body 13, but a concave member 61 is formed on the counter fuel injection side of the injection orifice plate 60, thereby the flat fuel chamber 51 is formed in parallel to the injection orifice plate 60 and immediately above the fuel upstream side of the respective injection orifices. Four injection orifices 60a, 60b, 60c and 60d formed in the injection orifice plate 60 correspond to the injection orifices 25a, 25b, 25c and 25d of the first working example, and have the same gradient angle α and the same injection orifice diameter d_1. Further, the distance from the outer peripheral side positions of the fuel inlets of the injection orifices 60a, 60b, 60c and 60d to the outer peripheral edge 201 of the fuel chamber 51 is d_2. $d_1 \leq d_2$ holds. The respective injection orifices are covered with the fuel injection side end surface 13a of the valve body 13.

[0028]

(Third Working Example)

FIG. 4 shows the fuel injection valve according to a third working example of the present invention. The constituent elements substantially the same as those of the first working example have the same reference numerals, and the explanations thereof will be omitted.

An injection orifice plate 70 has a concave member 71 on the counter fuel injection side, and a ring plate member 75 is held between the injection orifice plate 70 and the valve body 13. Four injection orifices 70a, 70b, 70c and 70d (70b and 70c are not shown) formed in the injection orifice plate 70 correspond to the injection orifices 25a, 25b, 25c and 25d of the first working example, and have the same gradient angle α and the same injection orifice diameter d_1. Further, the distance from the outer peripheral side positions of the fuel inlets of the injection orifices 70a, 70b, 70c and 70d to the outer peripheral edge 201 of the fuel chamber 51 is d_2. $d_1 \leq d_2$ holds. The respective injection orifices are covered with the plate member 75.

[0029]

In the above-described first working example, second working example and third working example, the bottom surface 15a of the concave member 15 formed in the valve body 13, the fuel injection side end surface 13a of the valve body 13 or the plate member 75 covers the respective injection orifices. In this construction, it may be arranged such that the respective injection orifices are formed on the further central side of the injection orifice plate, thereby the fuel inlets of the respective injection orifices are opened in the fuel downstream side opening of the inner peripheral surface 14, and the fuel injection side end surface 20a of the nozzle needle 20 covers the respective injection orifices.

[0030]

(Fourth Working Example)

FIG. 5 shows the fuel injection valve according to a fourth working example of the present invention. The constituent elements substantially the same as those of the first working example have the same reference numerals, and the explanations thereof will be omitted.

An injection orifice plate 80 having a thin disc shape is provided in the fuel injection side end

portion of the valve body 13. As shown in FIG. 5(B), inner injection orifices 80a and 80b and outer injection orifices 80c and 80d are formed in the injection orifice plate 80. The inner injection orifices 80a and 80b have a fuel inlet on the inner peripheral side of the virtual envelope line 200, while the outer injection orifices 80c and 80d have a fuel inlet on the outer peripheral side of the virtual envelope line 200. The inner injection orifice 80a and the outer injection orifice 80c, and the inner injection orifice 80b and the outer injection orifice 80d are respectively formed at the same gradient angle α in a direction away from the central axis 81 of the injection orifice plate 80 toward the fuel injection direction. $2° \leq \alpha$ 40° holds. The direction in which injection is made from the inner injection orifice 80a and the outer injection orifice 80c and the direction in which injection is made from the injection orifice 80b and the outer injection orifice 80d are opposite by 180°. Thus two-directional injection is performed.

[0031]

The fuel flowing along the inner peripheral surface 14 toward the injection orifice plate 80 is divided into a flow which collides against the

injection orifice plate 80 and runs toward the center in the inner fuel chamber 52 along the injection orifice plate 80 and a flow which runs along the injection orifice plate 80 toward the outside in the radial direction in the outer fuel chamber 53. As described above, the inner injection orifice 80a and the outer injection orifice 80c, and the inner injection orifice 80b and the outer injection orifice 80d are respectively formed at the same gradient angle α in the same direction to the central axis 81 of the injection orifice plate 80. However, the direction of fuel flow into the inner injection orifice 80a and that of fuel flow into the outer injection orifice 80c are opposite directions, and the direction of fuel flow into the inner injection orifice 80b and that of fuel flow into the outer injection orifice 80d are opposite directions. The liquid columns injected from the outer injection orifices 80c and 80d are inclined in a direction away from the central axis 81 of the injection orifice plate 80 to the central axis 82 of the injection orifices 80c and 80d. The liquid columns injected from the inner injection orifices 80a and 80b are inclined in a direction toward the central axis 81 of the injection orifice plate 80 to the central axis

82 of the injection orifices 80a and 80b. That is, as the fuel injected from the inner injection orifice 80a and that injected from the outer injection orifice 80c, and the fuel injected from the inner injection orifice 80b and that injected from the outer injection orifice 80d proceed so as to away from each other, collision among the liquid columns immediately below the respective injection orifices can be prevented. Accordingly, fuel atomization can be promoted.

[0032]

(Fifth Working Example)

FIG. 6 shows a fifth working example of the present invention. The constituent elements substantially the same as those of the fourth working example have the same reference numerals, and the explanations thereof will be omitted.

Inner injection orifices 95a, 95b, 95c and 95d, and outer injection orifices 95e, 95f, 95g, 95h, 95i and 95j are formed in an injection orifice plate 95. The inner injection orifices 95a, 95b, 95c and 95d have a fuel inlet on the inner peripheral side of the virtual envelope line 200, while the outer injection orifices 95e, 95f, 95g, 95h, 95i and 95j have a fuel inlet on the outer peripheral side of the virtual

envelope line 200. Further, fuel is injected respectively from the inner injection orifices 95a and 95b, the outer injection orifices 95e, 95f and 95g, and the inner injection orifices 95c and 95d, the outer injection orifices 95h, 95i and 95j, as two-directional injection.

[0033]

The fuel into the inner injection orifices 95a and 95b and the fuel into the outer injection orifices 95e, 95f and 95g flow in opposite directions. The fuel into the inner injection orifices 95c and 95d and the fuel into the outer injection orifices 95h, 95i and 95j flow in opposite directions. Thus mutual fuel collision immediately below the respective injection orifices can be prevented, and atomization of fuel spray can be promoted. Further, in the respective injection orifices to form spray, assuming that the distance between the inner injection orifice and the outer injection orifice is L_1, and that between the outer injection orifices is L_3, $L_1 < L_3$ holds. The distance between the outer injection orifices is longer than that between the inner injection orifice and the outer injection orifice. Accordingly, even in a case where the injection diameter is reduced and the number

of injection orifices is increased to obtain a desired injection amount for atomization of fuel spray, fuel collision immediately below the outer injection orifice can be prevented, and the atomization of fuel spray can be promoted.

[0034]

(Sixth Working Example)

FIG. 7 shows a sixth working example of the present invention.

Inner injection orifices 100a, 100b, 100c and 100d, and outer injection orifices 100e, 100f, 100g, 100h, 100i, 100j, 100k and 100m are formed in an injection orifice plate 100. The inner injection orifices 100a, 100b, 100c and 100d have a fuel inlet on the inner peripheral side of the virtual envelope line 200, while the outer injection orifices 100e, 100f, 100g, 100h, 100i, 100j, 100k and 100m have a fuel inlet between the virtual envelope line 200 and the outer peripheral edge 201. Further, fuel is injected from the inner injection orifices 100a and 100b, the outer injection orifices 100e, 100f, 100g and 100h, and the inner injection orifices 100c and 100d, the outer injection orifices 100i, 100j, 100k and 100m, as two-directional fuel injection.

[0035]

The fuel into the inner injection orifices 100a and 100b and the fuel into the outer injection orifices 100e, 100f, 100g and 100h flow in opposite directions. The fuel into the inner injection orifices 100c and 100d and the fuel into the outer injection orifices 100i, 100j, 100k and 100m flow in opposite directions. Thus mutual fuel collision immediately below the injection orifices between the inner injection orifice and the outer injection orifice can be prevented. Further, assuming that the distance between the inner injection orifice and the outer injection orifice is L_1, the distance between the inner injection orifices is L_2, and the distance between the outer injection orifices is L_3, $L_1 < L_2$ holds and $L_1 < L_3$ holds. Accordingly, as the distance between the inner injection orifices and that between the outer injection orifices are longer than the distance between the inner injection orifice and the outer injection orifice, fuel collision immediately below the inner injection orifices and the outer injection orifices can be prevented, and atomization of fuel spray can be promoted.

[0036]

(Seventh Working Example)

FIG. 8 shows a seventh working example of the present invention. The constituent elements substantially the same as those of the fourth working example have the same reference numerals, and the explanations thereof will be omitted.

A contact member 111 formed in a nozzle needle 110 can be seated on the valve seat 14a. Further, a fuel injection side end portion of the contact member 111 is projected toward the injection orifice plate 80, and a projection member 112 having a flat surface at its end is formed in the end portion.

[0037]

As the projection member 112 is formed, in a valve closed status where the contact member 111 is seated on the valve seat 14a, the capacity of the fuel chamber 51 is reduced in comparison with the fourth working example. As the ratio of injection amount of the fuel retained in the fuel chamber 51 in the valve closed status is lowered with respect to the entire fuel injection amount, the fuel injection amount can be controlled with high precision. In the first working example, second working example and third working example, the projection member can be formed in the fuel injection side end portion of the nozzle needle 20.

In the above-described fourth to seventh working examples, the concave member 15 is formed in the fuel injection side end portion of the valve body 13 thereby the fuel chamber 51 is formed. In this arrangement, the fuel chamber 51 may be formed by forming the concave member on the counter fuel injection side of the injection orifice plate.

[0038]

In the above-described plural working examples showing the aspects of implementation of the present invention, the fluid injection nozzle of the present invention is used in a gasoline engine fuel injection valve. The fluid injection nozzle of the present invention is applicable to any other construction as long as it atomizes and injects fluid.

[Brief Explanation of the Drawings]

[FIG. 1]

(A) is an enlarged cross-sectional view showing the injection nozzle of the fuel injection valve according to the first working example of the present invention. (B) is a plan view along an arrow B in A.

[FIG. 2]

A longitudinal cross-sectional view showing the fuel injection valve according to the first working

example of the present invention.

[FIG. 3]

(A) is an enlarged cross-sectional view showing the injection nozzle of the fuel injection valve according to the second working example of the present invention. (B) is a plan view along an arrow B in A.

[FIG. 4]

An enlarged cross-sectional view showing the injection nozzle of the fuel injection valve according to the third working example.

[FIG. 5]

(A) is an enlarged cross-sectional view showing the injection nozzle of the fuel injection valve according to the fourth working example of the present invention. (B) is a plan view along an arrow B in A.

[FIG. 6]

A plan view of the injection orifice plate of the fuel injection valve according to the fifth working example of the present invention viewed from the injection downstream side.

[FIG. 7]

A plan view of the injection orifice plate of the fuel injection valve according to the sixth working example of the present invention viewed from the

injection downstream side.

[FIG. 8]

An enlarged cross-sectional view showing the injection nozzle of the fuel injection valve according to the seventh working example.

[Explanation of Reference Numerals]

1 fuel injection valve

13 valve body

14 inner peripheral surface

14a valve seat

15 concave member

15a bottom surface

20 nozzle needle (valve member)

21 contact member

25 injection orifice plate

25a, 25b, 25c, 25d injection orifice

50 fuel passage (fluid passage)

51 fuel chamber (fluid chamber)

52 inner fuel chamber

53 outer fuel chamber

60, 70, 80, 95, 100 injection orifice plate

60a, 60b, 60c, 60d, 70a, 70b, 70c, 70d,

80a, 80b, 80c, 80d, 95a, 95b, 95c, 95d,

95e, 95f, 95g, 95h, 95i, 95j, 100a, 100b,

100c, 100d, 100e, 100f, 100g, 100h, 100i, 100j, 100k, 100m injection orifice

110 nozzle needle (valve member)

111 contact member

112 projection member

200 virtual envelope line

201 outer peripheral edge

[Type of Document] Abstract

[Abstract]

[Object] To provide a fluid injection nozzle to atomize spray.

[Means of Solution] A concave member 15 is formed in a fuel injection side end portion of a valve body 13. A fuel chamber 51 having a flat disc shape in parallel to and along an injection orifice plate 25 is formed between the concave member 15 and the injection orifice plate 25. The fuel chamber 51 is formed covering a predetermined range around injection orifices immediately above the fuel upstream side of injection orifices 25a, 25b, 25c and 25d. The four injection orifices 25a, 25b, 25c and 25d are formed in the injection orifice plate 25 on the same circumference. The injection orifices 25a, 25b, 25c and 25d having the same diameter are formed so as to be away from a central axis 26 of the injection orifice plate 25 toward a fuel injection direction. The respective injection orifices are covered with a bottom surface 15a of the concave member 15, and are opened in an outer fuel chamber 53. As the distance between the injection orifice 25a and the injection orifice 25b to perform injection in the same direction and the

distance between the injection orifice 25c and the injection orifice 25d are long, collision among liquid columns of fuel injected from the injection orifices immediately below the injection orifices can be prevented.

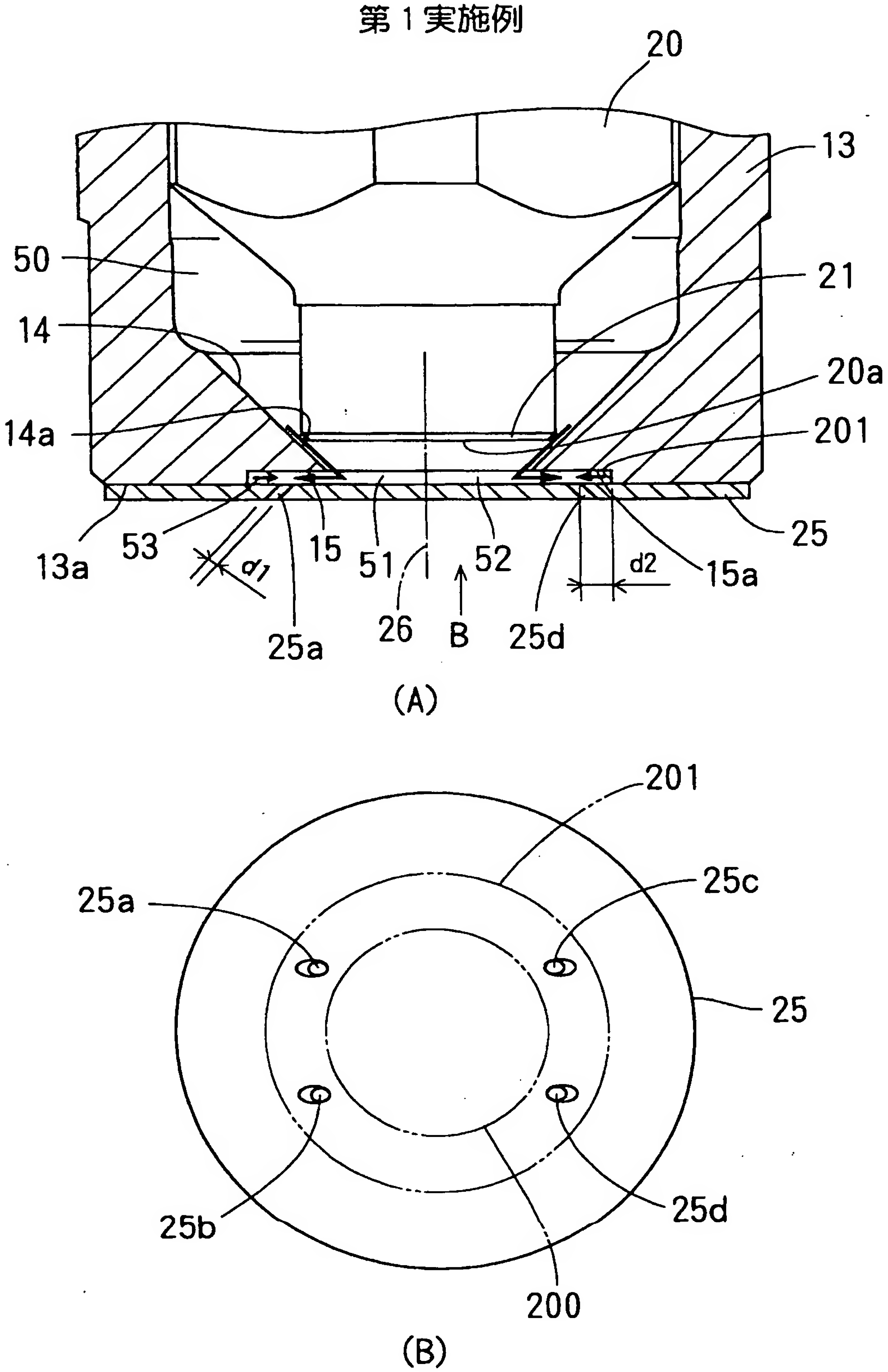
[Selected Drawing] FIG. 1

【書類名】　図面　[NAME OF DOCUMENT] DRAWINGS

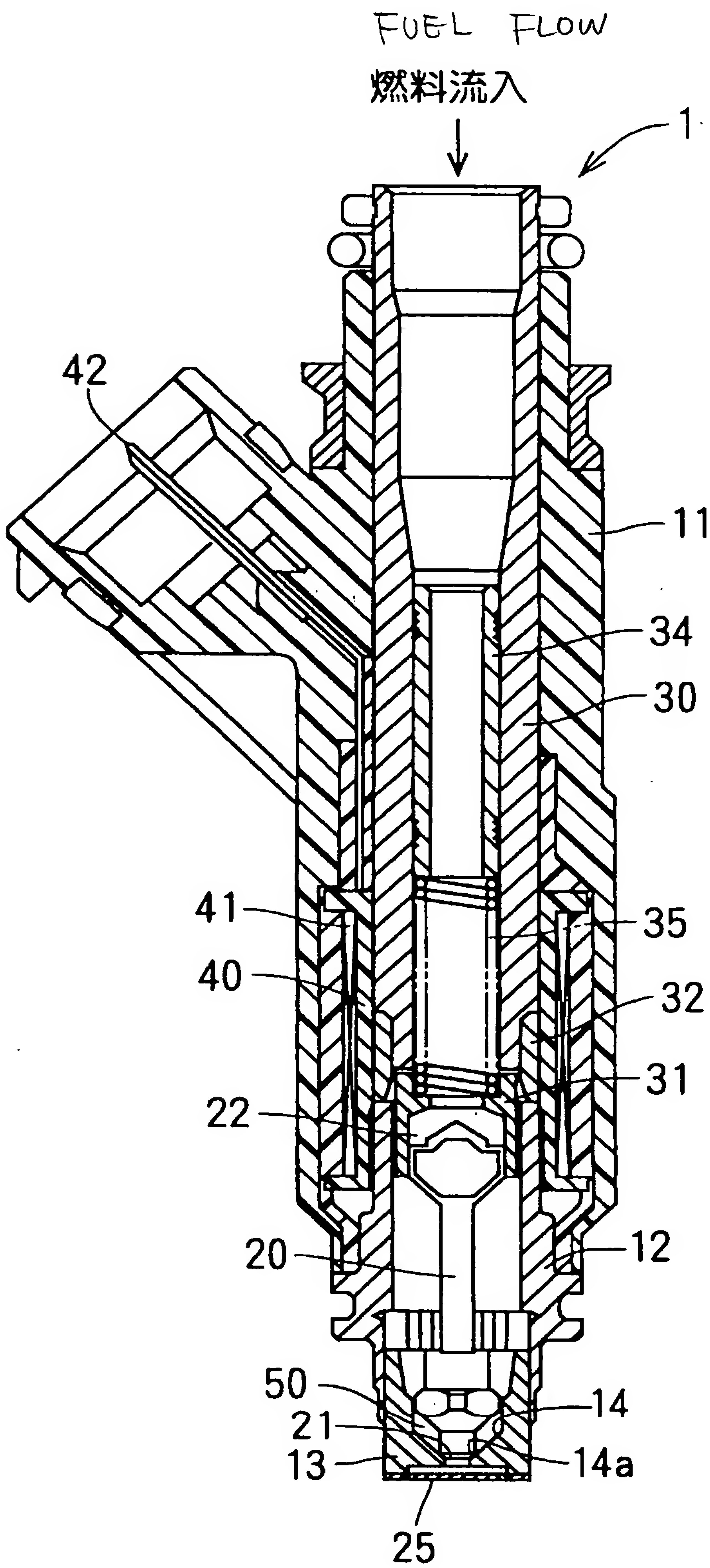
【図１】 [FIG. 1]

FIRST EMBODIMENT

第１実施例



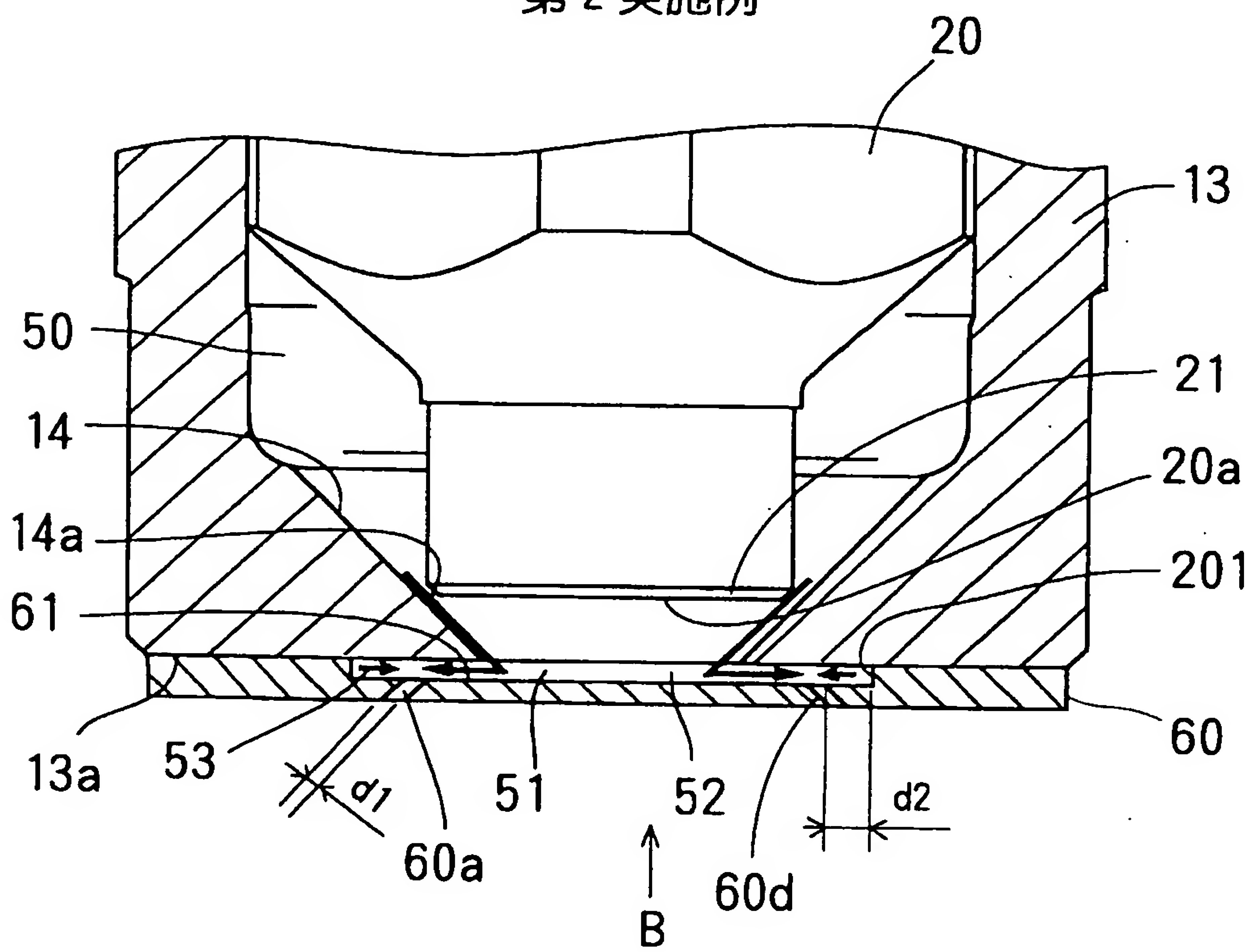
【図２】 [FIG.2]


FUEL FLOW
燃料流入
1
42
11
34
30
41
35
40
32
31
22
20
12
50
14
21
13
14a
25

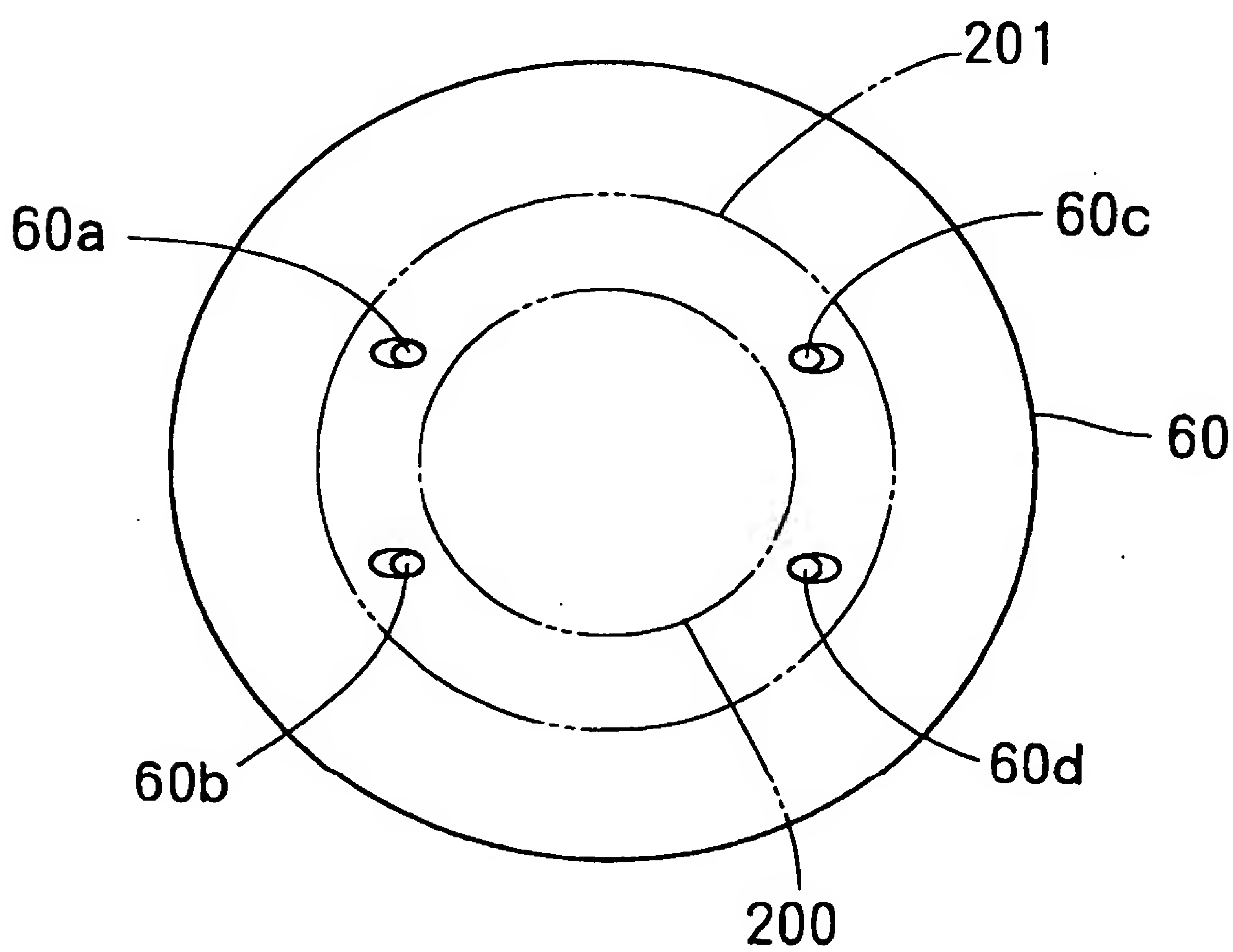
【図３】　[FIG. 3]

SECOND EMBODIMENT

第２実施例



(A)

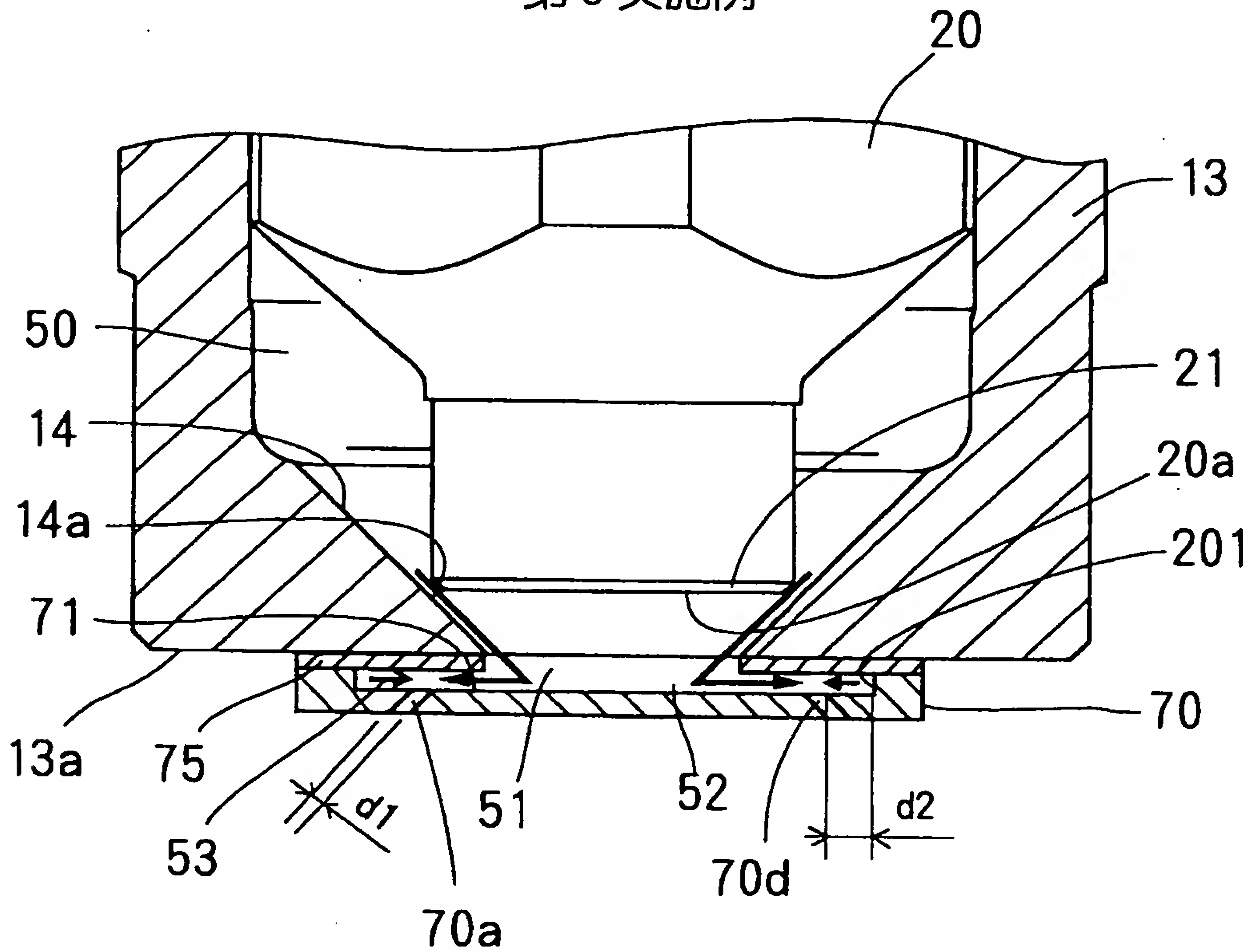


(B)

【図４】 [FIG.4]

THIRD EMBODIMENT

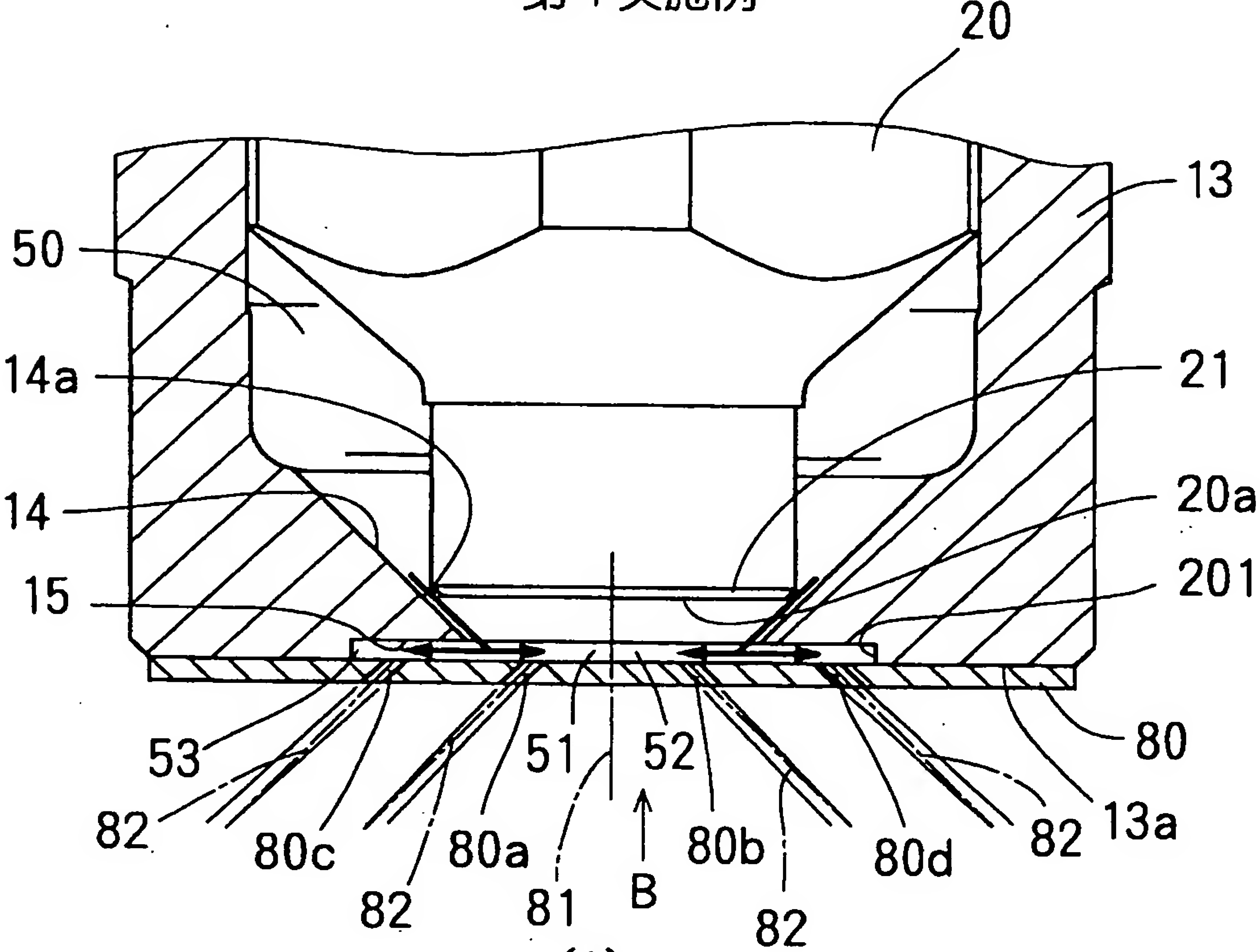
第３実施例



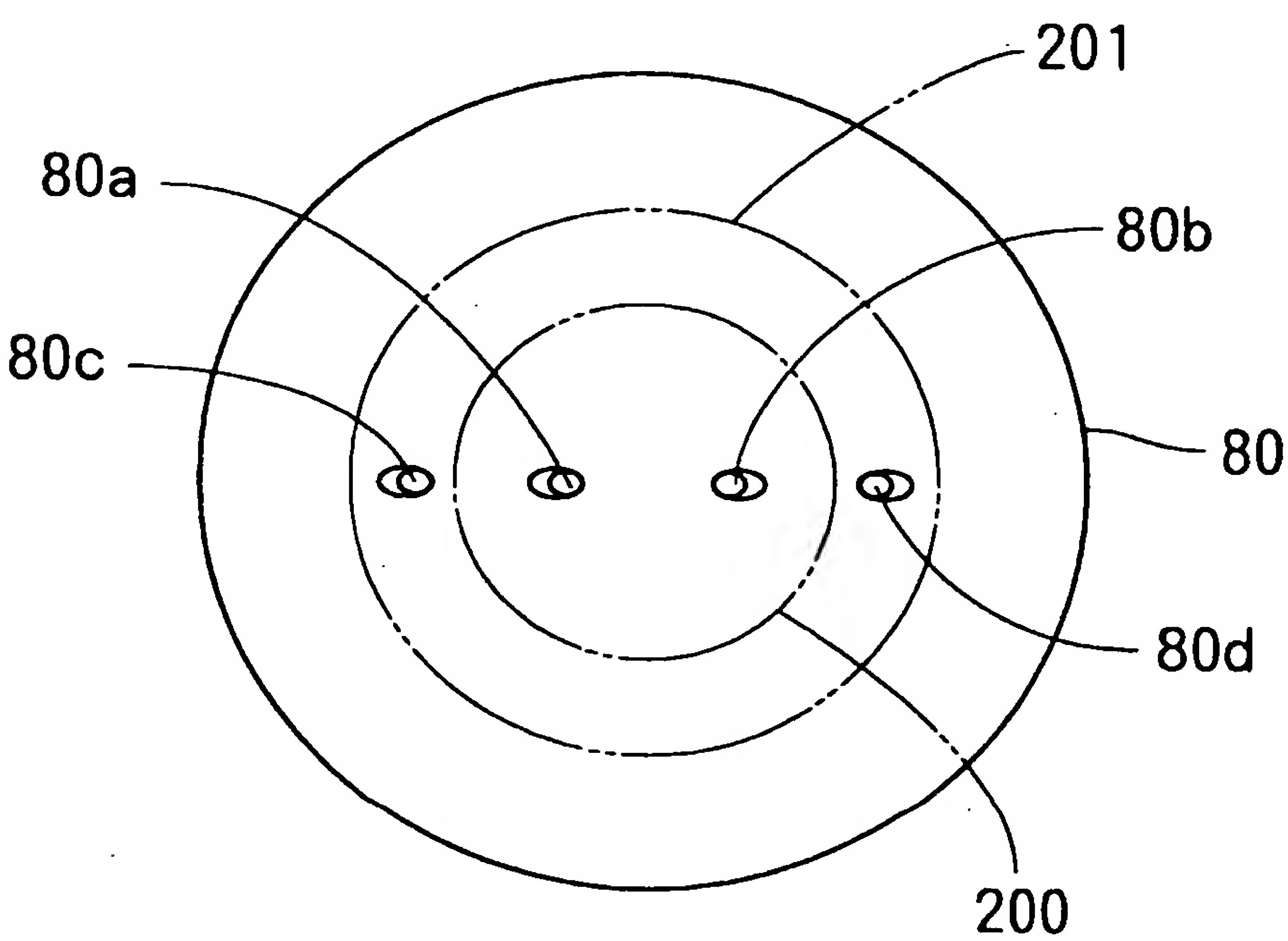
【図５】 [FIG.5]

FOURTH EMBODIMENT

第４実施例



(A)

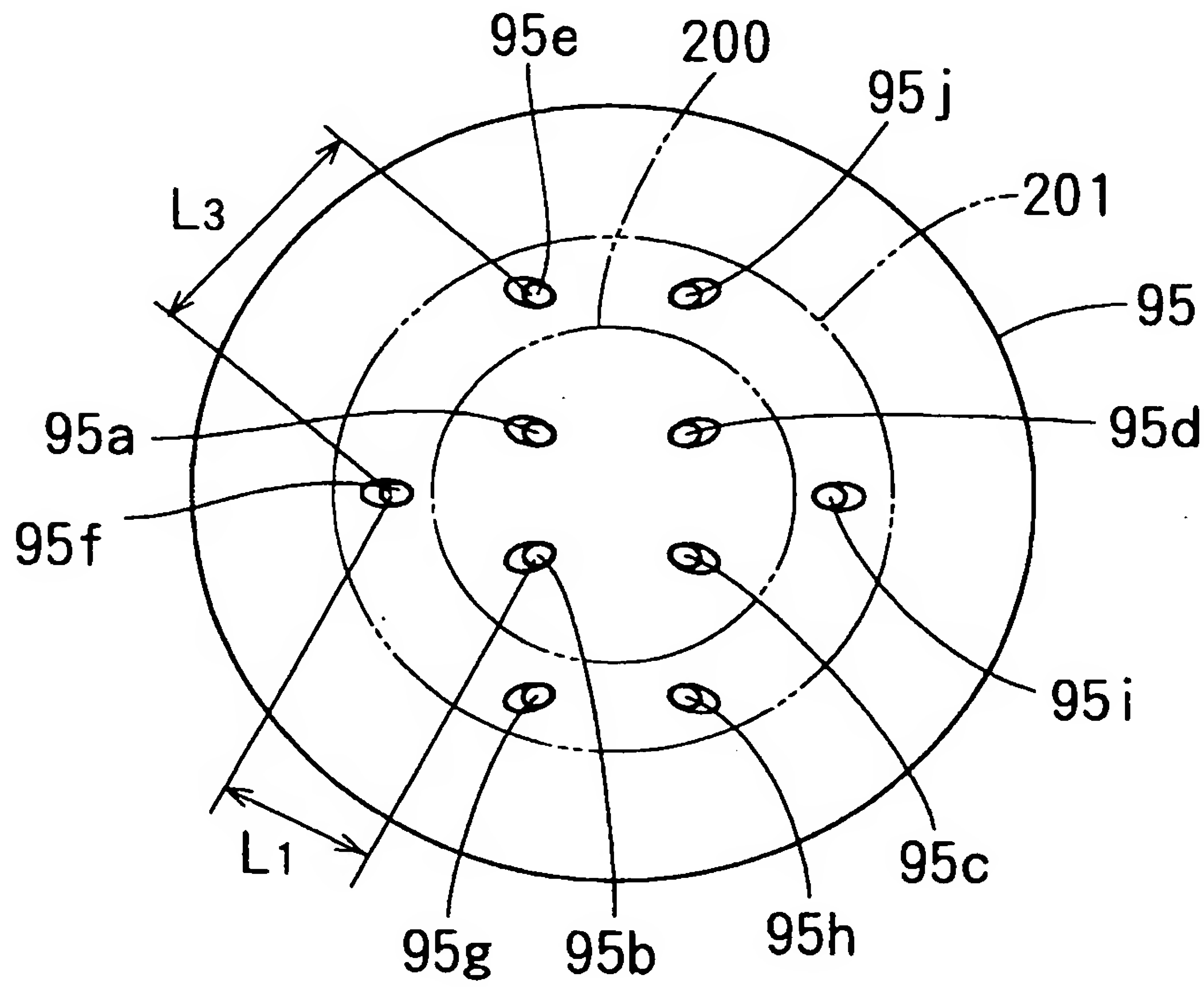


(B)

【図６】 [FIG.6]

FIFTH EMBODIMENT

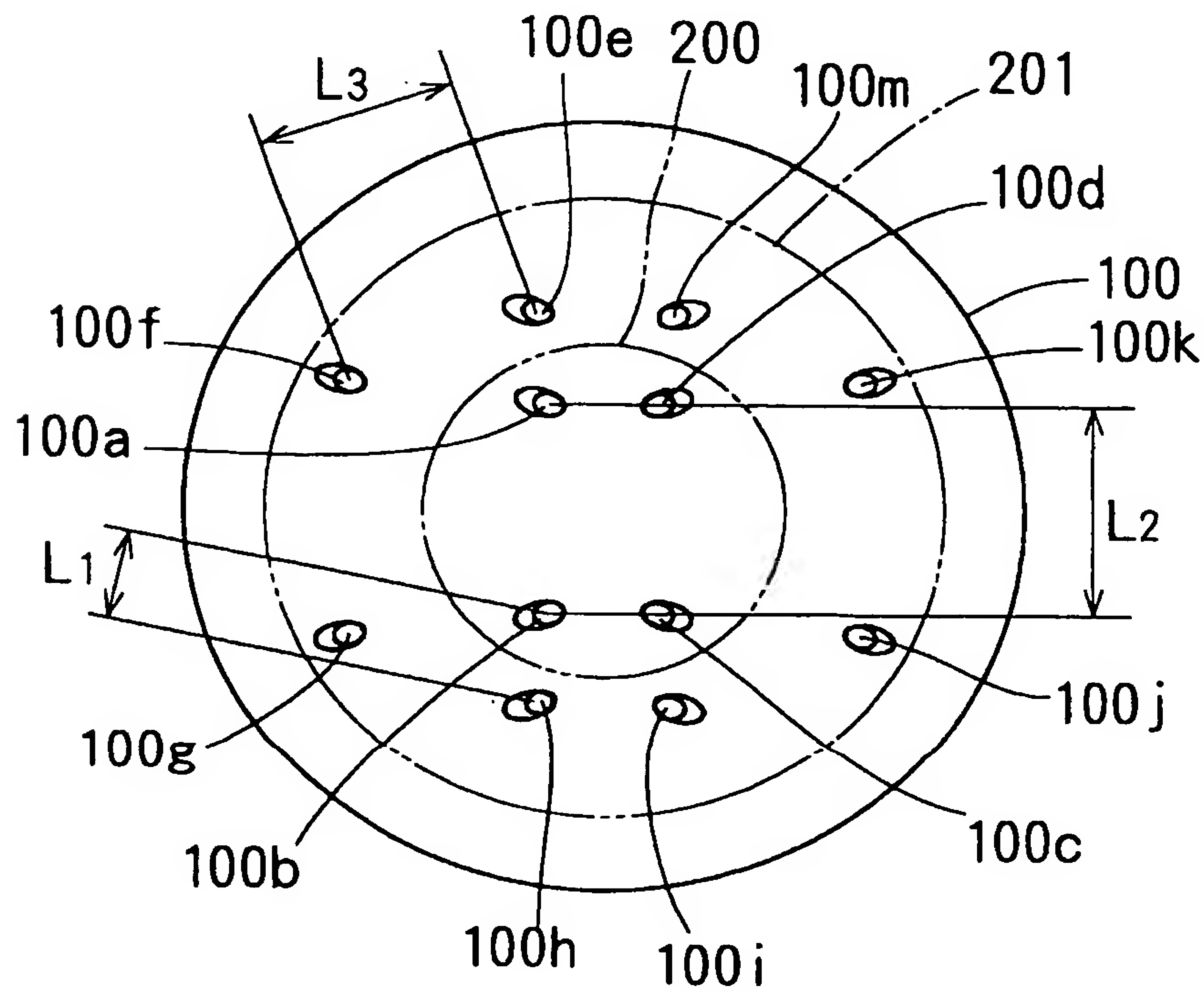
第５実施例



【図７】 [FIG. 7]

SIXTH EMBODIMENT

第６実施例



【図８】 [FIG.8]

SEVENTH EMBODIMENT

第７実施例